

## **CLAIMS**

I claim:

1. A method of recognizing a pattern in an image comprising the steps of:
  - (a) receiving data characterizing the pattern in pattern coordinate space;
  - (b) selecting feature points for the pattern;
  - (d) transforming the pattern from pattern coordinate space to a parameter space by creating a parameter table characterizing the pattern wherein pairs of feature points of the pattern are parameterized as a set of vectors with respect to at least two reference points;
  - (e) receiving data representing the image;
  - (f) extracting points of interest from the image data utilizing a low level vision process;
  - (g) initializing a parameter space accumulator comprising an array of cells;
  - (h) selecting pairs of extracted points parallel to each other in respect of their gradient angle and parameterizing the pairs of extracted points;
    - (i) comparing the values computed for pairs of extracted points with the parameter table and incrementing the cells of the parameter space accumulator corresponding to matching parameter values; and
    - (j) processing relative peaks in the accumulator array to determine a match with the desired template object.
2. The method of claim 1 wherein a distance between the pairs of feature points is calculated and is a parameter included in the parameter table.

3. The method of claim 1 wherein the pairs of feature points are parallel to each other in terms of their gradient angle.

4. The method of claim 1 wherein the parameter table characterizing the pattern is invariant to rotation, scale and translation.

5. The method of claim 3 wherein a parallel gradient identifier angle is computed for a pair of feature points as follows:

a line connecting the pair of feature points has a direction angle  $\sigma$ ,

the gradient angle at each of the feature points is assigned the value  $\psi$ , and

the parallel gradient identifier angle  $\varphi$  is computed by subtracting the direction angle from the gradient angle so that  $\varphi = \psi - \sigma$ .

6. The method of claim 5 wherein scale-invariance is included in the parameter table by normalizing the radial distance portion of the vector connecting a midpoint of the line between the pair of feature points to one of the at least two reference points, and including the normalized radial distance in the parameter table.

7. The method of claim 5 wherein the distance between the pair of feature points is computed and included in the parameter table.

8. The method of claim 5 wherein the direction angle  $\sigma$  between the pair of feature points is a parameter included in the parameter table.

9. The method of claim 5 wherein the parallel gradient identifier angle  $\varphi$  of the pair of feature points serves as an index for the parameter table.

10. The method of claim 1 wherein a match determined with the pattern is processed as a hypothesized match, and the parameter table entries corresponding to the relative peaks in the

accumulator array for the hypothesized match are inversely transformed from parameter space to depict test points in pattern space.

11. The method of claim 10 wherein the test points are superimposed upon the image.
12. The method of claim 11 wherein a distance transform is applied to determine a level-of-match between the test points and points of interest in the image.
13. The method of claim 12 wherein a matching metric is computed to quantitatively enumerate a level of match between the test points inversely transformed and the hypothesized pattern in the image.
14. The method of claim 13 wherein the root mean square average is computed to quantitatively enumerate the level of match.
15. The method of claim 1 wherein the pattern has an arbitrary shape.
16. The method of claim 1 wherein the parameter table is the only stored representation of the pattern in parameter space utilized in the comparison to the values computed for pairs of extracted points.
17. The method of claim 1 wherein a parallel gradient identifier angle is computed for a pair of extracted points as follows:
  - a line connecting the pair of extracted points has a direction angle  $\sigma$ ,
  - the gradient angle at each of the extracted points is assigned the value  $\psi$ , and
  - the parallel gradient identifier angle  $\varphi$  is computed by subtracting the direction angle from the gradient angle so that  $\varphi = \psi - \sigma$ .
18. The method of claim 9 wherein a parallel gradient identifier angle is computed for a pair of extracted points and is used to look up parameters corresponding to said parallel gradient identifier angle in the parameter table.